Cloud / Aerosol Lidar

Instrument: Aerosol Lidar

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Measurement Description:

The Aerosol lidar system measures profiles of aerosol and/or cloud backscatter at 532 and 1064 nm and aerosol/cloud depolarization at 532 nm. Backscatter profiles at the two wavelengths provide information on the relative concentration and spatial distribution of aerosol /cloud particles. Comparison of aerosol/cloud backscatter at the two-wavelengths provides some indication of particle size. Measurement of the depolarizing effect of the particles (that is, the degree to which the polarization of the backscattered light from the particles differs from the linear polarization of the transmitted laser light) provides an indication of particle phase.

The Aerosol Lidar is a piggy-back instrument on AROTAL lidar fielded by John Burris and Tom McGee of NASA Goddard Space Flight Center. The light source for the aerosol measurements is a Continuum 9050 Nd:YAG laser operating at 50 shots per second. The laser transmits approximately 600 mJ at 1064 nm, 200 mJ at 532 nm, and 350 mJ at 355 nm. AROTAL also employs an excimer laser transmitting at 308 nm and uses the molecular and Raman backscatter from the 355 and 308 beams to measure ozone and temperature. Backscattered light at all wavelengths is collected by a 16-inch diameter Newtonian telescope with a selectable field stop. In the aft optics assembly following the telescope and field stop, the UV signals are separated from the 532- and 1064-nm signals by a dichroic beam splitter. The UV signals are directed to the AROTAL receiver assembly and the 532- and 1064-nm signals are directed to the Aerosol Lidar receiver assembly. In the Aerosol Lidar receiver, a rotating shutter blocks the very strong near-range 532- and 1064-nm signals in order to reduce distortion in the relatively weaker signals from higher altitudes. The 532- and 1064-nm signals are separated by a dichroic beam splitter and the 532-nm signal is further separated into orthogonal polarization components using a polarizing beam cube. A computer-controlled half-wave plate in front of the polarizing beam cube is rotated so that the polarization of the 532 signals are parallel and perpendicular to the polarization of the transmitted laser pulses. The signals at both wavelengths and both 532-nm polarizations are transmitted to detectors at the Aerosol Lidar data acquisition rack via fiber optic cables. Each optical signal, the 1064-nm total backscatter and the 532-nm parallel and perpendicularly polarized backscatter, is directed to two separate detectors, with 10% going to one detector and 90% to the other, in order to more accurately measure the signals over their full

dynamic range. The 532-nm returns are measured with photo-multiplier tubes and the 1064-nm returns are measured with avalanche photo-diodes. Because of the high optical signal levels, all data are acquired in analog mode, using 12-bit analog-to-digital converters. The instrument operates under both daytime and nighttime lighting conditions, with a slight degradation in data quality during the daytime.

The signals measured by instrument are composed of backscatter from both air molecules and aerosol/cloud particles. The aerosol/cloud component of the signal is estimated using coincident density profiles derived from the UV/Raman backscatter data from the AROTAL lidar and DAO assimilation model results. Data products derived from the measurements include the following:

Total scattering ratio at 532 nm;

Total scattering ratio at 1064 nm;

Aerosol volume backscatter coefficient at 532;

Aerosol volume backscatter coefficient at 1064 nm; and

Aerosol depolarization ratio at 532 nm.

The archived products will be produced over an altitude range extending from approximately 5 km to 20 km above the aircraft. Data are acquired at nominal resolutions of 15-m vertical and 500-m horizontal (2-s integration). The archived products will be averaged to lower resolutions. The resolution of the archived products will depend on the objectives of the flight, the observed scene, and the lighting conditions. Data at other resolutions may be made available upon request.